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Agricultural Ground Limestone

BY

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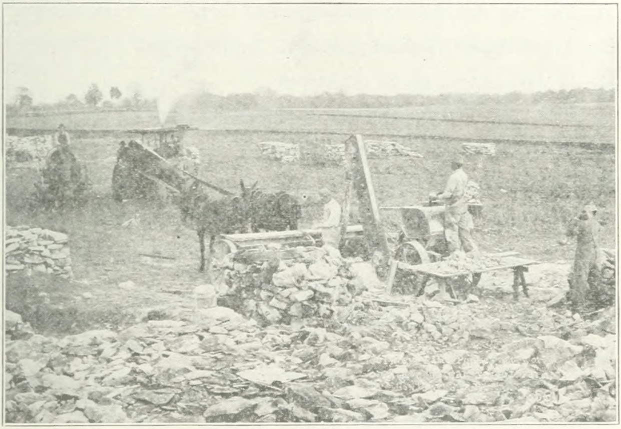

A portable lime crusher may be utilized as an efficient aid in developing local resources

THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO
AGRICULTURAL COLLEGE EXTENSION SERVICE
CLARK S. WHEELER, *Director*

FREE—Cooperative Agricultural Extension Work—Acts of May 8 and June 30, 1914

AGRICULTURAL GROUND LIMESTONE

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2. Does limestone increase crop yields?
3. Why does limestone increase crop yields?
4. Why do soils become acid?
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6. Do commercial fertilizers make the soil acid?
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OHIO AGRICULTURAL EXPERIMENT STATION

Chas. E. Thorne, Director

Wooster, Ohio.

This bulletin has been carefully examined and its statements compared with the original records at the Ohio Agricultural Experiment Station, and I believe that the statements contained therein are fully justified.

Chas E Thorne

Director.

AGRICULTURAL GROUND LIMESTONE

1. **What is Agricultural Ground Limestone?**—The Ohio Lime and Limestone law says: "Agricultural ground limestone shall be the term used to designate limestone of such a degree of fineness that 95 percentum will pass a ten mesh sieve, 50 percentum will pass a fifty mesh sieve, and 30 percentum will pass a one-hundred mesh sieve." In this way agricultural ground limestone is distinguished from "agricultural limestone meal" and "agricultural limestone screenings" both of which must also by law meet certain specifications in regard to fineness. Ten, fifty and one hundred mesh sieves have ten, fifty and one hundred wires respectively to the linear inch.

2. **Does Limestone Increase Crop Yields?**—Numerous tests have been made by the Ohio Experiment Station to determine the value of lime for increasing crop yields. The most notable ones have been conducted at Wooster on soil which, in its need of lime, is typical of much of the state east of Sandusky and Columbus. The increase in crop yields from the use of 2 tons of limestone per acre once every 5 years has been as follows:

INCREASE PER ACRE FROM 2 TONS OF LIMESTONE, WOOSTER

CROP	FERTILIZED LAND	MANURED LAND
Corn	13 bu.	10 bu.
Oats	5 bu.	2 bu.
Wheat	5 bu.	5 bu.
Clover	2000 lbs.	1600 lbs.
Timothy	2600 lbs.	2250 lbs.

The results obtained at Wooster will hardly apply to soils of western Ohio, as soil conditions differ. The tests at Germantown, in Montgomery County, are more indicative of what may be expected on soils of the type of those of western Ohio. At Germantown, limestone has produced the following increases in crop yields:

INCREASE PER ACRE FROM 2 TONS OF LIMESTONE, GERMANTOWN*

CROP	FERTILIZED LAND	MANURED LAND
Tobacco	none	none
Wheat	none	1½ bu.
Clover	250 lbs.	50 lbs.

The increase in crop yields at Germantown has not been sufficient to pay the cost of the limestone and the extra labor involved in its use. This does not mean that limestone never increases crop yields profitably in western Ohio, but that there is less need for it there than in the eastern part of the state.

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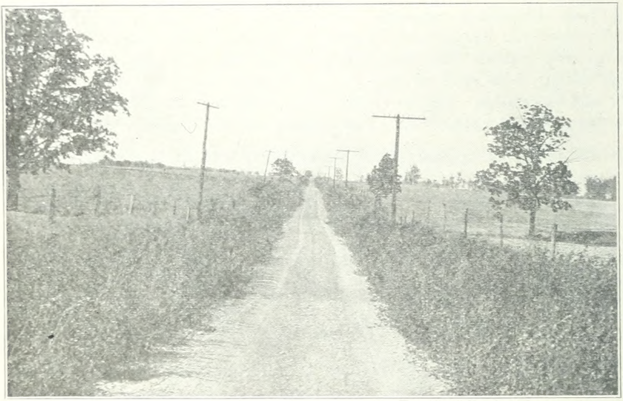
*Ohio Experiment Station, Bulletin 285.

3. Why Does Limestone Increase Crop Yields?—Soils which have been farmed for a number of years have a tendency to become acid. This tendency is more marked in some soils than in others. When the soil becomes acid it is necessary, in order to continue to grow large crops, that something be done to destroy the acid which has accumulated. A number of substances can be used for this purpose. Wood ashes, for example, are very effective, but the supply is limited. The only substance which is available in large quantities and which can be had at small cost is ground limestone or some product formed by burning limestone.

Limestone not only destroys the acid and makes the soil sweet, but it supplies calcium and usually more or less magnesium, both of which are used by the plant for food purposes.



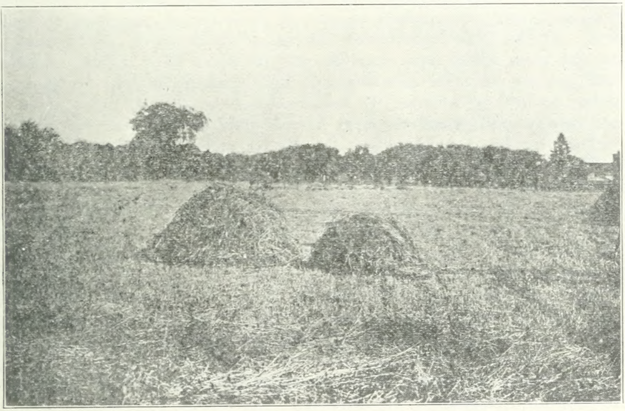
Sweet clover thrives with abundance of limestone

The bacteria which bring about the decay of organic matter and those which fix the nitrogen of the air work much more rapidly in soils well supplied with lime. Under such conditions they can supply the growing crop with an abundance of nitrogen. A dark, vigorous, green color of plants is sure to follow the application of lime to an acid soil.

4. Why do Soils Become Acid?—The minerals which form the soil particles are composed of bases and acids. When the composition is such that the bases predominate, the minerals, or the soils formed from them, are alkaline, but when the acids predominate, the minerals or soils are acid. In the course of farming operations bases are removed from soils more rapidly than the acids, as crops make use for food purposes more largely of the former than of the latter. During the process of weathering by which rocks and soils are continually decomposed, more or less of the mineral matter of soils is leached away thru drainage water. Leaching removes the basic part of soils more than the acid part. Amounts varying from 200 to 800 pounds of lime have been found in drainage waters from an acre in 1 year. The combined results of crop growth and weathering eventually bring soils to a condition where the acid minerals predominate over the basic. Soils are then said to be acid.

It has long been the popular opinion that plowing under of organic matter, especially green material, causes the production of organic acids and consequently increases soil acidity. Recent tests at the Ohio Experiment Station have indicated, however, that in well drained soils the incorporation of organic matter, either dry or green, does not increase the lime requirement.

5. **Does Manure Make the Soil Acid?**—At the end of several years of investigation by the United States Department of Agriculture, soils that had received no manure had a limestone requirement of 2520 pounds per acre, whereas those to which unleached manure had been applied regularly had a requirement of 2200 pounds.*



Many farmers have been convinced by trying limestone

At the Ohio Experiment Station, certain plots of land have been manured at regular periods in the rotation for the past 20 years. Other plots by their side have had no manure. When tested for lime requirements, the unmanured plots were found to need 1720 pounds of limestone per acre, whereas those that had received manure had a requirement of only 1380 pounds.

Additional indications concerning this point are obtained from the crop yields on unfertilized and manured land at the Ohio Station. On unfertilized land the use of lime has increased the yield of wheat 7½ bushels per acre, whereas on manured land the increase from lime has been only 5 bushels. This would indicate that the use of manure has decreased rather than increased the need for lime. A study of this and other evidence leads to the conclusion that the use of stall or unleached manure does not make the soil acid, but instead helps to conserve the calcium and other bases of the soil.

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*Journal of The American Society of Agronomy. Volume IX. No. 1, page 34.

6. **Do Commercial Fertilizers Make the Soil Acid?**—The effect of commercial fertilizers on soil acidity varies. This is well illustrated by ammonium sulphate and nitrate of soda. At both the Ohio Station and the Pennsylvania Station, on plots where ammonium sulphate has been used for the past 20 to 35 years and no lime applied, the soil has become very acid. Very little clover grows on these plots and the yields of other crops are less than those secured on plots which receive nitrogen in forms other than sulphate of ammonia. On the other hand, where nitrate of soda has been used on the acid soils of these stations there are indications that the increase in crop yields is not accounted for entirely by the nitrogen it carries, but partly by the soda, which is a base and which accordingly reduces acidity.

Bone, basic slag and floats are carriers of phosphorus that contain small amounts of lime, and it may be assumed without question that they have no tendency to make soils acid. Concerning acid phosphate, there is more or less argument. Theoretically acid phosphate should make the soil acid, as it is an acid salt and a small amount of limestone is necessary to make it neutral. At the Ohio Experiment Station, after 20 years' use of acid phosphate, the plots which have received this fertilizer have a lime requirement of 1320 pounds per acre in contrast to 1720 pounds per acre for those plots receiving no acid phosphate. It would seem from this that the plots which do not receive acid phosphate need lime at least as badly as those to which acid phosphate has been applied. Results on farms indicate the same to be true. The liberal use of acid phosphate even on quite acid soils usually results in a greater growth of clover, and if this is taken as an index of the need for lime it would seem that there is no reason to fear that acid phosphate is a material that makes this need more imperative.

7. **How May I Know Whether My Soil Needs Limestone?**—There are some indications which give general information in regard to a soil's need for lime. Of these indications the manner of growth of the clover crop is perhaps the most simple. When clover fails to make a thrifty start or begins to die out after the grain crop is harvested, and finally has its place taken by timothy and weeds, an acid soil is indicated. However, clover may exhibit the same general tendencies because the soil has been depleted of its fertility by the failure to follow a systematic plan of soil treatment. Where applications of manure and fertilizers—especially those containing phosphorus—fail to remedy the trouble, the indication of the need of lime is doubly strong.

Another general indication is the growth of sorrel. Sorrel and other weeds in a meadow indicate that some condition has interfered with the best growth of clover. However, the mere presence of sorrel in spots where clover has been winter-killed or otherwise destroyed is not necessarily an indication of an acid soil. Nature always attempts to cover such places with vegetation, and sorrel occasionally may be the weed chosen for the purpose. But in those sections where sorrel appears regularly year after year, and becomes worse as soils get older, the need for lime is strongly indicated.

There are also some tests for determining the need of lime in soils. The most common and the one most widely used in the field is the litmus test. This test merely indicates whether or not a soil is acid. It does not tell how much lime is needed. It is not infallible, but with a little care on the part of the tester it will give valuable information in many cases. Any farmer who suspects an acid condition of his soil can well afford to secure litmus paper and make a few tests.

There are various other tests to determine the need for lime in soils.

Most of these are adapted for use in the laboratory rather than in the field. Some not only show where acidity exists but also give an idea of the amount of lime needed.

Samples of soil sent to the Soils Department of The Ohio State University will be tested for acidity and those sending them will be informed as to their need for lime.

Perhaps the safest way for the average man to tell whether his soil needs lime is to try it. If a marked increase in crop yield, particularly of the clover crop, is obtained from the use of lime on land that has been manured and fertilized the soil needs lime and it should be applied, provided the increase obtained is sufficient to pay for the cost of the lime.

8. **Is Limestone as Good as Other Forms of Lime?**—For several years the Ohio Experiment Station has been conducting tests to determine the relative merits of the various forms of lime. In these tests quicklime, hydrated lime, ground limestone and air-slacked lime have been used in such amounts that the same neutralizing value has been represented in each form. The results are given in the table below.

COMPARISON OF FORMS OF LIME*

FORM OF LIME	YIELDS PER ACRE		
	Corn	Oats	Clover
	bu.	bu.	lbs.
Quicklime	71	51	5200
Hydrated lime	69	53	5300
Air-slacked lime	71	52	5500
Ground limestone	72	51	5200

In these Ohio tests limestone has been as effective as any other form. Furthermore, these tests indicate that if ground limestone will supply, when spread on the ground, the greatest neutralizing value for the money expended and labor involved, it well can be used in preference to the other forms.

9. **How Can the Neutralizing Value of Limestone be Determined?**—The power of limestone and limestone products to neutralize or destroy soil acids is measured by their content of calcium and magnesium in the form of carbonates, oxides and hydroxides. Under the new Ohio Lime and Limestone Law, analyses are so stated that the buyer is able to compare the various lime and limestone products more easily than was possible from analyses as formerly stated. The law now requires that analyses of lime and limestone shall state the minimum percent of calcium, the minimum percent of magnesium, and the total neutralizing value in terms of calcium carbonate. The statement of the minimum percents of calcium and magnesium shows whether the material in question is a pure calcium product or one containing magnesium. As magnesium is slightly more effective per pound than calcium in destroying soil acids it is necessary to reduce the neutralizing power of these elements to a common basis in order that their combined effect in any lime or limestone may be represented accurately. Calcium carbonate is the unit of measure by which this is done. By testing a sample of a lime or limestone the chemist can determine the equivalent in pounds of calcium carbonate of a ton

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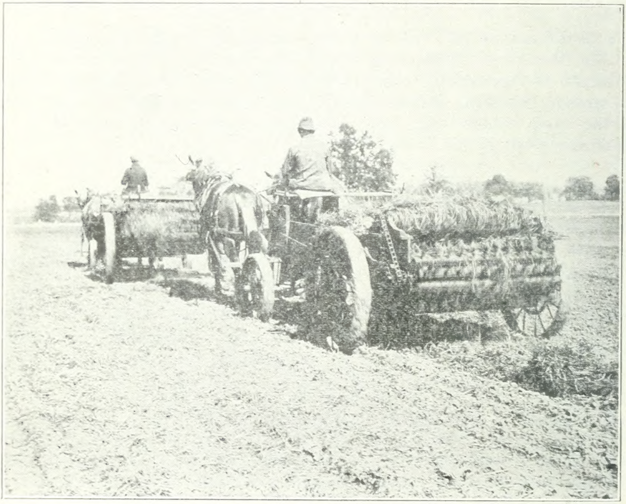
*Ohio Agricultural Experiment Station, Circular 144.

of the material tested. The equivalent may be larger or smaller than 2000. A comparison of the numbers reported for any two limes, for any two limestones or for any lime and limestone shows the relative neutralizing value of the materials compared. Thus, if a certain agricultural ground limestone were reported as having a neutralizing value per ton of 1800 pounds of calcium carbonate, and the value per ton for a certain hydrated lime were given as 2250 pounds of calcium carbonate, a comparison of 1800 with 2250 would show that 1¼ tons of this limestone are equal in neutralizing power to 1 ton of this particular hydrated lime.



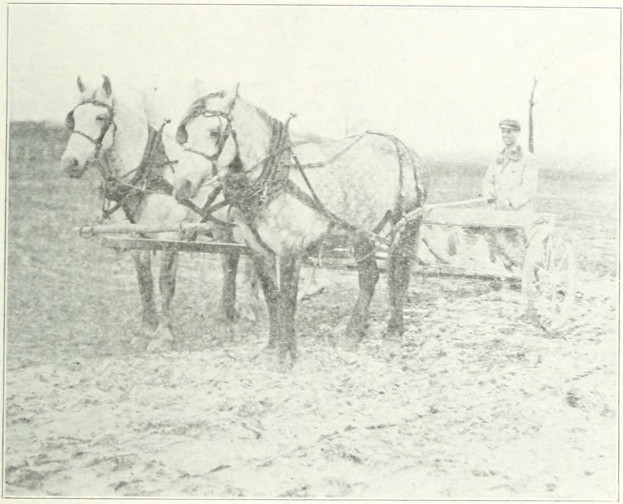
Unleached manure helps greatly in the management of acid soils

Those who are buying lime or limestone should study the analysis furnished by the manufacturer before purchasing any particular brand, and note how this compares with the analyses of other brands which may be available. They should also secure a copy of the Official Lime and Limestone Report. This contains the analyses of all limes and limestones sold in the state. It may be obtained free of charge by writing to The State Board of Agriculture, Columbus.

10. **Is Magnesium in Limestone Objectionable?**—In so far as we have any experimental evidence on this matter at the present time, there does not seem to be any reason why we should discriminate against magnesian limestone. Magnesium carbonate has been applied to acid soils with good results in much larger amounts than would be practical under farm conditions. Since a pound of magnesium will destroy more acid than a pound of calcium, it would seem that the magnesian limestones should sell at least as readily as the non-magnesian limestones. If the limestone is applied partly for its

calcium and magnesium content for plant food purposes, the relative need of the soil and crop for these two elements would determine whether the magnesian or non-magnesian limestone was preferable.

11. **How Fine Should Limestone be Ground?**—Experiments show that the efficiency of limestone increases with the fineness of grinding. As the cost of grinding also increases there is a practical limit to the degree of fineness which can be demanded. If limestone is ground so that 95 percent of it goes thru a ten mesh screen and none of the fine material is removed, it is satisfactory for general use. Such limestone will contain about 50 percent of material that passes thru a 50 mesh screen and about 30 percent that passes thru a 100 mesh screen. Limestone of this fineness distributes easily and is quickly effective.



Overcoming one "limiting factor" of an acid soil

The Ohio Lime and Limestone Law classifies limestone products according to fineness of grinding into agricultural ground limestone, agricultural limestone meal and agricultural limestone screenings. Of these different materials ground limestone is most effective and limestone screenings least so. The latter are seldom used except in the neighborhood of quarries, where the length of haul and the cost makes it practicable to apply several tons per acre.

12. **Are Limestone Crushers Practicable for Farm Use?**—There are two factors which must be considered in this connection. One is the cost of securing limestone, and the other is the ease and convenience. The following table gives the cost of limestone in 1914 at the Hamilton County Experiment Farm when purchased and also when crushed on the farm.

COST OF LIMESTONE, HAMILTON COUNTY EXPERIMENT FARM.*

By Purchasing:	
Ground Limestone 51.35 tons at $1.00 (f.o.b. Cols.)	$ 51.35
Freight—Columbus to Mt. Healthy, 51.35 tons at $1.15	59.05
Hauling—Mt. Healthy to Experiment Farm, man and team 14 days at $4.00	56.00
Total cost	$166.40
Cost per ton	3.24
By Crushing on the Farm:	
Collecting limestone—8¾ man hours at $ .20	$ 1.75
Hauling (21 tons rock) 31¼ man hours at $ .20	6.25
62½ horse hours at $ .10	6.25
Labor—(3 men to work at crusher) 42 man hours at $ .15	6.30
Engine hire—14 hours at $ .70	9.80
Charge for crusher (estimated)	7.50
Coal—1100 lbs. at $3.75 per ton	2.06
Total cost	$39.91
Cost per ton	1.90

At the Hamilton County Farm, home grinding was more economical than purchasing. This indicates that in many communities the limestone problem should be solved by the use of portable crushers. To do this in most cases will require some cooperative effort. The cost of crushers is such as to practically prohibit their ownership for individual use except in case of very large farms, but where it is possible for a few men to cooperate and buy a crusher the cost to each is not serious. A more satisfactory method in many ways is to guarantee a definite amount of custom work to any man who will agree to buy a pulverizer. By so doing, it is sometimes possible to induce the owner of an engine to purchase a crusher and use it when the engine is not engaged in threshing or silo filling.

A big advantage of portable limestone crushers lies in the fact that they eliminate the long haul from the railroad to the farm. Many farmers who will not use lime when forced to haul the material several miles would do so if limestone could be pulverized on the farm.

13. **Is Marl as Valuable as Limestone?**—The value of marl for correcting soil acidity depends on its content of calcium carbonate. Some marls are almost pure calcium carbonate, while others have a considerable percentage of impurities. Before using any particular marl its purity should be ascertained. The Soils Department of The Ohio State University will test samples of marl and advise as to their suitability for use on soils.

14. **How Much Limestone Should Be Applied Per Acre?**—The amount of limestone to apply per acre depends upon several factors. First and of most importance is the degree of acidity of the soil to be limed. This may vary from very slight to very strong, in which case the amount of limestone needed to make the soil neutral would vary from a few hundred pounds to several tons. It is desirable to have the soil practically neutral or even slightly alkaline, but in many cases this is impracticable because of the cost of securing

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*Monthly Bulletin, Ohio Experiment Station, Volume I, page 31.

the required amount of limestone. The Wisconsin Station secured some very good results from the use of limestone when applied in only one-half the amount required to make the soil neutral. The experience of many farmers is to the effect that very good results often are secured on acid soils by the application of a small amount of lime, even tho this amount is far from sufficient to make the soil completely neutral.

The second factor, influencing the amount of limestone to use, is the crops that are grown. Crops vary considerably in their tolerance of acid conditions. Among the legumes, alfalfa and sweet clover are more sensitive to soil acidity and require more limestone than red clover. Red clover in turn requires more limestone than alsike and mammoth clover. In fact, these last two often do well on soils that are quite acid. The soybean is another legume that grows well on soils that are deficient in limestone.

Limestone is "first aid treatment" for this meadow

Because of the many variable factors involved, no definite statement can be made as to the amount of limestone that should be applied. A general recommendation is to apply two tons of limestone per acre. The Ohio Station found that on the acid soil at Wooster it is profitable to apply this amount once every 4 or 5 years.

15. **When Should Limestone be Applied?**—Limestone may be applied at any time of the year when it can be worked into the surface soil. There probably is no better time than just before the corn crop, provided it can be applied without unduly delaying corn planting. Applied at this time, cultivation of the corn mixes the limestone thoroly thru the soil. The spring time, however, is usually a busy period and oftentimes limestone is more conveniently applied after the oat stubble is plowed for wheat. Preparation of the seed bed works it into the soil. If potatoes come in the rotation, it is better to lime after this crop rather than before it. The use of limestone does not cause potato scab, but if the scab is on the seed or in the soil, it may develop more seriously where limestone has been applied.

Farm operations are of such a nature that the work cannot always be done just as desired. Rather than not lime at all it may be good practice to apply limestone at a time in the rotation that is convenient, but which does not admit of its being worked into the soil. Occasional cases are reported where applying limestone on the wheat during the fall or winter has given excellent results. Also a few cases are reported where men have secured good results by applying limestone to the sod ground during the winter prior to plowing for corn.

It is not always wise to wait until it is time to apply limestone before hauling it. A delay in shipment may cause the limestone to arrive too late to be used as planned. If a small building can be used as a storage house, limestone may be purchased and hauled at any time during the year. This assures a supply whenever the time of application arrives.

16. **Can Limestone be Mixed with Manure and Commercial Fertilizers?**—If limestone is scattered over manure it tends to increase the loss of ammonia into the air, altho this loss is not nearly so serious with limestone as it is with quicklime. If mixed with commercial fertilizers, limestone may cause the reversion of the water soluble phosphoric acid in the fertilizers. While there may be no particular harm in having this occur, it is usually considered better to have the reversion take place in the soil after the acid phosphate has been applied.

Limestone may be used safely on the same soil with manure and commercial fertilizers. The manure may be applied to the soil and plowed under, then the limestone spread and worked into the surface soil. At planting time the fertilizer application may be made. In this way all three materials may be used on the same soil within a short period and one will not interfere with the efficiency of the others.

17. **Will Limestone take the Place of Commercial Fertilizers?**—Limestone will not take the place of commercial fertilizers, but its use on acid soils may serve to change the content of the fertilizers that need be purchased. As the great function of limestone is to make it possible to grow better crops of clover and other legumes, it can readily be seen that its use will help make unnecessary the purchase of nitrogen.

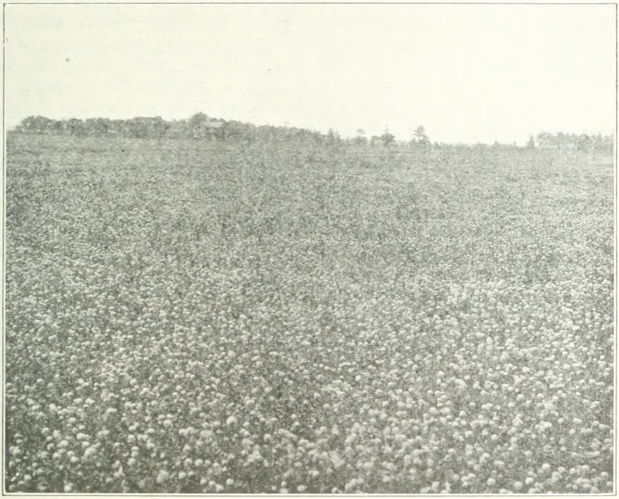
The use of limestone also may help indirectly to make unnecessary the purchase of potash. There has been much discussion as to whether limestone actually liberates potash from the soil. The best evidence to date is to the effect that the amount of potash liberated in this manner is insignificant. The decay of organic matter is the most important means of making available the potash of the soil. In this connection the use of limestone on acid soils makes possible larger crops, which in turn makes possible more organic matter to decay in the soil and as a result of this decay a greater liberation of potash.

The use of limestone will not affect the purchase of phosphorus. The supply of phosphorus in the soil is so small that it is necessary to apply fertilizers containing it, after the soil has been limed as well as before. As a matter of fact soils that need limestone usually are also badly in need of phosphorus, so that one cannot take the place of the other. For best results on acid soils both must be used.

18. **What Can be Done if Limestone Cannot be Obtained Economically?**—In spite of the many advantages to be gained by the use of limestone many acid soils are farmed from year to year without having it applied. There are a number of reasons for this. Many farmers are still unconvinced that

the liming of acid soil is sufficiently profitable to make it worth while. Then unfortunately much of the land that needs limestone is far from the source of supply and several miles from a railroad. In many such sections the roads do not admit of hauling heavy loads during the winter time, and limestone, if secured at all, must be hauled during the busy summer season. Also in many cases there are numerous things besides limestone for which money is needed, and to buy limestone may mean increasing temporarily an already heavy debt.

The question of what can be done on acid soils under such conditions is of vital interest to many farmers. Common observation teaches that on many acid farms large crop yields are secured without the use of limestone and farming is on a profitable plane. Where such is the case one almost invariably finds a good farmer in charge. It is worth while to study the methods employed by such men.



It takes limestone to grow clover like this

Observation in the field, together with a study of the relationship between crops and soils, teaches that much can be done to improve acid soils without the use of limestone, or at least by the use of a minimum amount. A few writers have mentioned the possibility of developing an "acid agriculture" by choosing only those crops which do fairly well on an acid soil. In such a system alfalfa and sweet clover would have no place, but alsike clover, soybeans, cowpeas and vetch could be used to advantage. Of the non-legumes many of the ones commonly grown are more or less tolerant of acid conditions.

The use of manure helps materially in the management of acid soils without the use of limestone. The manure should by all means be protected from leaching before being applied to the soil, as a large part of the bases of manure may be lost where this takes place. These bases are badly needed by acid soils.

The addition to the soil of a large amount of organic matter is also important. This is sometimes difficult to obtain, as the organic matter obtainable is in direct proportion to the size of the crops grown and on extremely acid soils large crops are not always easily produced. However, the adoption of a short rotation with greater efforts made to have good sods to plow under will help much in supplying organic matter. The use of manure also helps in this regard.

Finally, but by no means least important, liberal quantities of phosphorus fertilizers should be applied. Floats, bone meal, basic slag and acid phosphate form a group from which selection may be made to meet any condition. All of these have a tendency to decrease the soil's need of lime.

At the Strongsville Experiment Farm in Cuyahoga County crops have been grown on acid soil for 20 years. Where the crops receive poor treatment, the returns are not profitable, but where unleached manure is used regularly, phosphorus applied liberally and good sods turned under the yields are such as to offer encouragement to those who feel that their conditions do not permit of the purchase of limestone. These things may be performed by the man 15 miles from a railroad almost as easily as by the one who lives within sight of the station.

The use of limestone on acid soils should be encouraged. An "acid agriculture" is not desirable. It is merely an inferior alternative to be adopted where conditions do not permit of the purchase of limestone.

Neither the man who can secure limestone, nor the one who cannot, should look upon it as a cure for all soil troubles. Proper crop rotations, the preservation of manure, maintenance of organic matter and the use of phosphorus are important factors in the foundation of soil fertility. Added to these limestone forms a more stable foundation and makes possible the more easily to build up a high type of permanent soil fertility.

THE AGRICULTURAL COLLEGE EXTENSION SERVICE

Department of Soils

The Department of Soils takes this opportunity to inform the farmers of the state as to what it is able to do toward helping solve the immediate soil problems of the farm.

1. Any sample of soil sent to the soils laboratory will be examined as to its need for lime. The sample will also be compared with samples already in the laboratory of which analyses are known and recommendations will be made as to treatment for soil of the type represented. An accompanying letter should give the history of the treatment which the field has undergone for the last 20 years. This should include information concerning the rotation followed, disposal of crops, manure applied, etc.

Soil samples should be chosen as follows: with a spade dig a hole 7 inches deep at ten or fifteen places. From the side of each hole remove a thin slice with the spade. After drying and pulverizing the sample it should be mixed thoroly and enough soil chosen from the mixture to fill a baking powder can. This should then be sent for examination.

2. Samples of limestone may be sent for a test as to their purity. Six or eight pieces the size of a walnut should be chosen for the sample. This applies only to limestone which it is desired to utilize by burning or by means of portable crushers. Samples of commercial limestone are not included.

3. In counties having no Agricultural Agent, upon request of five neighboring farmers a representative of the Department of Soils will visit the farms and select samples typical of the soil on the farms visited and these samples will be examined as to content of lime, nitrogen and organic matter. A written report will contain recommendations for soil treatment on the farms examined.

4. All samples should be sent by parcel post to the Department of Soils, Ohio State University, Columbus, Ohio. Reports will be returned within a week or ten days after the sample has been received.